5.2.14 FACILITY ACCIDENTS

Facility accidents are unplanned, unexpected, and undesirable events that have the potential to harm workers, the public, and the environment. Accidents in an EIS are defined as undesired events, or combinations of events, that can occur during or as a result of implementing an alternative and that have the potential to result in human health impacts or environmental impacts. Accidents may occur as a result of natural phenomena, such as earthquakes, from operational errors, or failures of process equipment. Accidents can result in exposure to direct health impacts (exposure to fires or explosions), exposure to ionizing radiation, exposure to hazardous chemicals, or combinations of these hazards. This section presents a summary of the accident analysis for the waste processing alternatives described in Chapter 3. Section C.4.1 in Appendix C.4, Facility Operational Accidents for Waste Processing Alternatives, contains further discussion of this accident analysis. Figure C.4-5 in Appendix C.4 provides the visual relationship of the *Idaho High-Level Waste and Facilities Disposition EIS Facility Accidents Technical Resource Document (TRD;* DOE 1999) components to the facility accident summary contained in this section of the EIS.

Each alternative and option being considered in this Idaho HLW & FD EIS requires an analysis of facility accidents as one of the environmental impacts, particularly to human health and safety, associated with its implementation. An accident analysis is performed to identify indirect environmental impacts associated with accidents that would not necessarily occur but which are reasonably foreseeable and could result in significant impacts from air releases. Although most safety assurance evaluations of facility accidents indicate that industrial accidents are the largest single contributor to the overall health and safety risk associated with the implementation of an alternative, industrial accident risks are evaluated separately in this EIS (see Section 5.2.10, Health and Safety).

Since the potential for accident impacts varies substantively for different facilities and operations associated with waste processing alternatives, facility accidents may provide a key discriminator among waste processing alternatives.

Accident analysis requires a technical information base that includes descriptions of potentially bounding accidents (scenarios), as well as the likelihood of occurrence, source term, and predicted consequences of each accident. The scope of the accident analysis involves identification of bounding accidents for HLW management activities and determination of source terms for each bounding event. Primary activities performed in the analysis includes the following:

- Identification of the processes associated with each alternative
- Definition of a set of process element evaluations for each alternative that comprehensively assesses accidents and can be jointly used to establish bounding accidents for each alternative
- Identification and description of the bounding abnormal, design basis, and beyond design basis accident for each process element
- Development of source terms and description of the basis for estimating source terms and consequences for the bounding accidents
- Calculation of potential impacts to human receptors from each accident

The scope of this facility accident analysis does not include:

- Evaluation of facility accidents occurring at sites other than INEEL
- Evaluation of accidents associated with transportation of radioactive or hazardous material, other than transportation within a site as part of facility operations; the impacts of transportation are presented in Section 5.2.9
- Evaluation of the bounding accident potential associated with facility closure

activities; the impacts of facility closure and disposition activities are included in Section 5.3.11.

5.2.14.1 Historical Perspective

Most of the historical INEEL accidents, such as the release of chlorine gas at Argonne National Laboratory-West on April 15, 1994, are less severe than the postulated accidents analyzed in this study. The primary historical cause of fatalities to INEEL workers has been industrial accidents, and risks to the public from INEEL facility industrial accidents have been analyzed in detail and have been determined to be low (DOE 1991).

Consequences of accidents can involve fatalities, injuries, or illnesses. Fatalities can be prompt (immediate), such as in construction accidents, or latent (delayed), such as cancer caused from radiation exposure. While public comments received in scoping meetings for this EIS included concerns about potential accidents, the historical record shows the industrial accident rate for DOE facilities at the INEEL is somewhat lower (Millet 1998) compared to the rate in the DOE complex overall. The historic accident rate compares favorably to national average rates compiled for various industry groups by the National Safety Council (NSC 1993) and Idaho averages compiled from State statistics (DOE 1993a).

One measure of the expected effectiveness of site management in controlling facility accident risks at future facilities is the effectiveness of current management in controlling risk to workers. The Computerized Accident Incident Reporting System database that chronicles injuries, accidents, and fatalities to workers at INEEL can be used as a measure of management effectiveness in controlling the risk of fatal industrial accidents to involved and co-located workers. This assumption is based on the fact that control over all accidents in the workplace is a requirement for controlling fatal accidents.

Historically at INEEL, fatal accidents represent approximately 0.1 percent of all accidents. Accident data are typically collected in terms of different types of activities. Based on the different types of activities in standard accident databases, "construction" is considered the most applicable to the activities that will be occurring at the INEEL during HLW processing. From the SNF & INEL EIS (DOE 1995), the rate of injury/illness for construction activities in the DOE complex was 6.2 per 100 worker-years and the rate of injury/illness for construction activities in private industry was 13 per 100 worker-years from 1988-1992. From 1993-1997, the rate of injury/illness for construction activities at INEEL was 5.4 per 100 worker-years (Fong 1999). These data support the conclusion that the injury/illness rate at INEEL is slightly lower than DOE as a whole and significantly lower than private industry. The fatality rate from 1993-1997 was approximately 0.05 per 100 worker-years higher than the previously reported fatality rate to 1992 and is due to the occurrence of a fatality at the INEEL in 1996. An additional INEEL fatality occurred in 1998. Incorporating this 1998 fatality into the industrial accident rate using a Baysean update results in a fatality rate of 0.14 per 100 worker-years, which is clearly greater than the fatality rate for the DOE complex as a whole. Additional detail in the derivation of industrial accident rates is provided in Appendix C.4.

During implementation, each of the waste processing alternatives temporarily adds risk to humans and the environment during the life of the project. Implementation risk results from the activities associated with implementing a waste processing alternative. This implementation risk, which can be thought of as the "risk from doing something," is illustrated qualitatively in Figure 5.2-6 as the potentially negative impact of a waste processing alternative. Implementation risk to humans is the sum of risk from facility accidents (i.e., accidents involving release of or exposure to radioactive or chemical materials), transportation accidents, industrial accidents, and accrued occupational exposures during operations. Facility accidents involve risk to the public and are a potential discriminator for waste processing alternatives. Environmental risk is represented on Figure 5.2-6 as both the initial

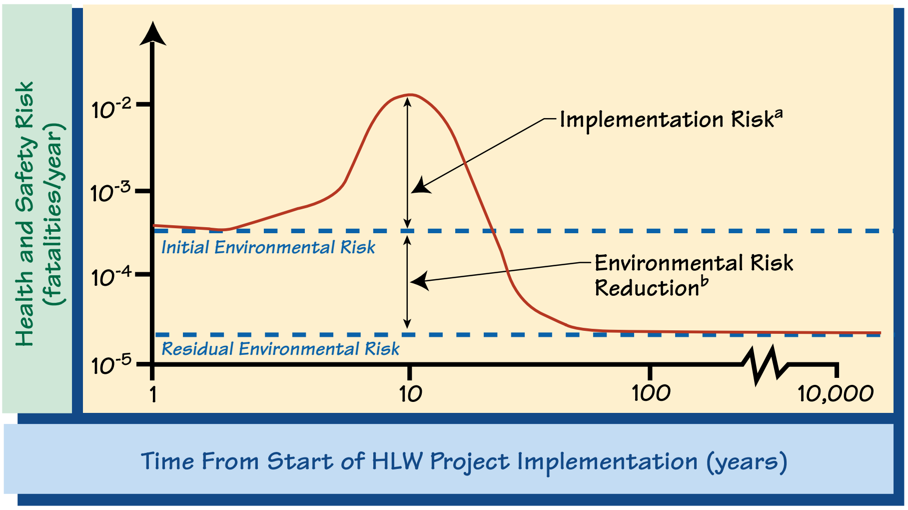

FIGURE 5.2-6.
Conceptual relationship of implementation risk to environmental risk.

a Implementation Risk is that which results from the activities associated with implementing the waste processing alternative. Implementation Risk includes risk to involved workers, co-located workers, the public, and the environment. Implementation Risk is the sum of risk from facility accidents (i.e., release of radioactive and chemical materials), industrial accidents, and accrued occupational exposures during normal operations. Significant disparities in the expected Implementation Risk can be a discriminator among waste processing alternatives.

b Environmental Risk is associated with existing environmental contamination or with materials that could constitute a hazard to humans or the environment, if released. The purpose of the waste processing alternatives is the reduction of environmental risk associated with past processes at INTEC that resulted in accumulation of HLW and related wastes. Environmental Risk Reduction involves removal of contamination or the hazards associated with materials at a facility by removing them, by rendering them immobile, or by otherwise rendering them inaccessible to human or environmental contact. The effectiveness of Environmental Risk Reduction is a potential discriminator among waste processing alternatives.

environmental risk (upper dashed line) and the long term residual environmental risk (lower dashed line). Environmental impacts were not evaluated separately, human impacts were the primary focus rather than flora and fauna impacts. Observational data is not available to predict future performance of planned waste processing facilities. Safety assurance documents such as facility safety analysis reports and safety analysis reports for packaging provide some sense of public risk concerns at DOE facilities and operations. A perspective on the implementation risk for waste processing alternatives is obtained through an analysis of radiological and toxicological accidents supported by the TRD.

Relative contribution to worker risk from facility accidents, industrial accidents, and occupational exposures is shown qualitatively in Figure 5.2-7. Figure 5.2-7 shows that, for some waste processing alternatives, implementation risk is more likely to be dominated by industrial accidents and unavoidable occupational exposures. What is important is that facility accident risks to workers typically bound those risks to the public. Facility risk to workers will be dependent on the effectiveness of environmental safety and health management at future facilities associated with waste processing. An effective environmental, safety, and health program that manages risk to workers and the public is assumed in this accident analysis. The accident analysis presented in this section appraises the implementation risk of facility accidents for future facility operations associated with each of the major waste processing alternatives.

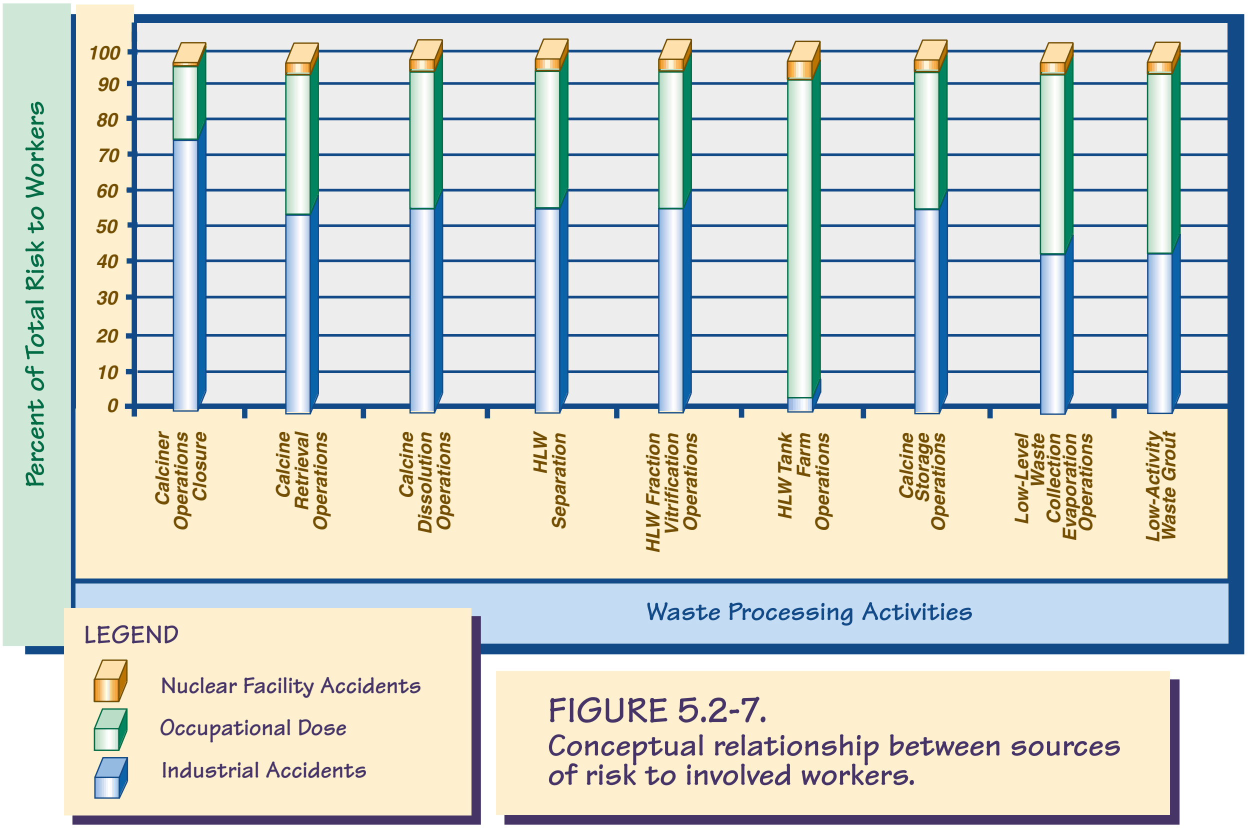

FIGURE 5.2-7.
Conceptual relationship between sources of risk to involved workers.

5.2.14.2 Methodology for Analysis of Accident Risk to Noninvolved Workers and the Public

The technical approach and methods used in this accident analysis are intended to be fully compliant with DOE technical guidelines for accident analysis (DOE 1993b). These same guidelines allow the incorporation by reference of information that was previously addressed in other EIS documents. For activities occurring at Hanford under the Minimum INEEL Processing Alternative, facility accidents due to the processing of INEEL waste are effectively analyzed in Jacobs (1998). Accidents that could occur at Hanford during the processing of INEEL waste are bounded by accidents that are defined for the TWRS waste treatment alternatives. In addition, accidents at WIPP are examined in site-specific NEPA documents prepared for WIPP. This approach is not only permissible in DOE National Environmental Policy Act guidelines, they constitute a reasonable method of assuring that there is not a "double counting" of impacts associated with DOE activities. The DOE technical guidelines require the identification of three broad frequency ranges of potential accidents: abnormal, design basis, and beyond design basis accidents that are reasonably foreseeable and bounding for each alternative. As used in this EIS, abnormal events have frequencies equal to or greater than once in a thousand years of facility operation; design basis accidents have frequencies equal to or greater than once in a million years but less than once in a thousand years; and beyond design basis events have frequencies equal to or greater than once in ten million years but less than once in a million years. Within each frequency range, a bounding accident is determined so that any other reasonably foreseeable accident within a frequency range would be expected to have smaller consequences. The results are point estimates of maximum, reasonably foreseeable accidents by frequency category rather than a cumulative assessment of all possible accidents in each category.

This EIS defines a bounding accident as the reasonably foreseeable event (i.e., not requiring extraordinary initiating events or unrealistic progressions of events to occur during facility operation) that has the highest environmental impacts, particularly human health and safety impacts, among all reasonably foreseeable accidents identified for an alternative. This analysis discusses possible causes, assumptions, likelihoods of occurrence, and consequences for the bounding accident within each frequency category. Some accidents in the abnormal and design basis frequency ranges are based on existing analyses, such as facility safety analysis reports.

DOE performed accident analyses of waste processing facilities that are currently operating using data from facility safety analysis reports, facility operating experience, and probabilistic data from similar facilities and operations. Accident analysis of facilities that have not yet been designed (including most facilities proposed in this HLW & FD EIS to implement waste processing alternatives) uses information primarily from technical feasibility studies performed to ascertain process feasibility and identify process implementation costs (Fluor Daniel 1997). Information from the TRD used in the accident analysis includes preliminary inventories of material at risk, process design data, and some overall design features. Methods used to assess the potential for facility accidents are based primarily on DOE guidance, experience with similar systems, and understanding of the INTEC site layout. Documents such as facility safety analysis reports, safety reviews, and unresolved safety question determinations evaluate the potential for harm as part of the process of assuring high levels of safe facility operation. While these documents are available for existing facilities, they have not been available to DOE given the early state of development in most waste processing alternatives.

The EIS accident analysis of HLW treatment facilities incorporates the following three levels of screening analyses (definition of special terms follows the three levels):

1. DOE performed a screening evaluation of major facilities and identified various operations needed to implement waste processing alternatives (referred to herein as process elements) to assess the potential for significant facility accidents. Process element attributes that infer the existence of significant process hazards include inventories of hazardous or radioactive materials, dispersible physical forms, and the potential for energetic releases during operation.

2. DOE performed detailed accident analyses beginning with the description of activities, inventories, and conditions pertinent to the accident analysis. DOE compared a standardized set of "accident initiating events" against the described set of activities, inventories, and operating conditions to identify and describe accident scenarios.

3. Finally, DOE grouped accident scenarios into the three major frequency categories and the accident scenario in each frequency range with the highest potential risk of health and safety impacts to offsite persons or noninvolved onsite workers (the potentially bounding accident scenario) was selected for consequence evaluation.

An "accident scenario" consists of a set of causal events starting with the "initiating event" that can lead to release of radioactive or hazardous materials with the potential to cause injury or death. Therefore, along with the initiator, accident scenarios include events such as the failure of facility safety functions or failure of facility defense in depth features.

An accident "initiating event" of varying frequency and severity can challenge and sometimes degrade the safety functions of the facility. For purposes of the accident analysis, DOE considered six classes of initiating events/accidents types in detailed accident reviews:

- Fires during facility operations
- Explosions during facility operations
- Spills (radiological or hazardous material)

- Criticality (nuclear chain reaction)
- Natural phenomena (for example: flood, lightning, seismic event, high wind)
- External events (human-caused events external to a facility that may impact the safe operation and integrity of the facility)

A team of qualified analysts performed a system review to evaluate potential accidents that could arise from operation of the identified facilities and activities under each waste processing alternative. The systems accident analysis team included personnel knowledgeable in HLW management, facility operation, radiological hazards, chemical hazards, hazards identification, source term development, and consequence evaluation. The accident analysis team employed a systems review process to determine the bounding accident scenarios for each activity. Also, the accident analysis team sought to capture and retain the intermediate work steps that comprised the scenario selection process. This secondary goal served the dual purpose of ensuring traceability of the selection process, as well as providing a link to the source term estimation and evaluation.

The screening process identified a subset of process elements requiring detailed accident analysis to assess the potential for bounding accidents to occur. In some cases, the bounding accident potential for vulnerable process elements of several alternatives could be evaluated using a single accident evaluation. The resulting set of required accident analysis used to identify potentially bounding accident scenarios for the waste processing alternatives is shown in Table 5.2-37. From Table 5.2-37, there are 22 separate accident analyses used to identify potentially bounding accident scenarios. The 22 accident analyses are identified on Table 5.2-37 as the shaded blocks. Each accident analysis identifies potentially bounding accident scenarios in the three frequency classes, abnormal events, design basis events, and beyond design basis events.

Appendix C.4 provides a discussion of the forms used to document the bounding accident identification process. In these forms, the hazards identification block contains the six initiators or accident types with the accident frequency categories previously described. Sabotage and terrorist activities were not addressed separately, since sabotage and terrorism are not random or accidental events. The consequences from these acts are likely bounded by events already defined as accidents.

Source Term Identification

Radiological Releases – For non-criticality radiological releases, the source term is defined as the amount of respirable material that is released to the atmosphere from a specific location. The radiological source term for non-criticality events is dependent upon several factors including the material at risk, material form, initiator, operating conditions, and material composition. The technical approach described in DOE-STD-3010 (DOE 1994) is modified in the Safety Analysis and Risk Assessment Handbook (Peterson 1997) and was used to estimate source terms for radioactive releases. This approach applies a set of release factors to the material at risk constituents to produce an estimated release inventory. The release inventory was combined with the conditions under which the release occurs and other environmental factors to produce the total material released for consequence estimation. Factors applied in the DOE-STD-3010 (DOE 1994) source term method and additional details with respect to source term estimation are contained in Appendix C.4 and in the TRD.

For criticality events, the source term also includes a prompt dose, which is a function of the number of fissions. Criticality was assessed in each accident analysis evaluation. Only one bounding criticality accident scenario was identified in the accident analysis evaluations. DBE 21, Transuranic Waste Stabilization and Preparation for Transport to the Waste Isolation Pilot Plant, identified an inadvertent criticality during transuranic waste shipping container loading operations as a result of vulnerability to loss of control over storage geometry. This scenario is identified in Table 5.2-38 under the Minimum INEEL Processing Alternative. The

Table 5.2-37. Accident evaluations required.

Vulnerability to accidents by process element[a]	Project Element Designator	No Action Alternative	Continued Current Operations Alternative	Separations Alternative: Full Separations Option	Separations Alternative: Planning Basis Option	Separations Alternative: Transuranic Separations Option	Non-Separations Alternative: Hot Isostatic Pressed Waste Option	Non-Separations Alternative: Direct Cement Waste Option	Non-Separations Alternative: Early Vitrification Option	Minimum INEEL Processing Alternative
New Waste Calcining Facility Continued Operations			AA1[b]		AA1		AA1	AA1		
New Waste Calcining Facility High Temperature & Maximally Achievable Control Technology Mods	E2		AA2		AA2		AA2	AA2		
Long-Term Onsite Storage of MTRU waste/SBW	E3	AA22								
Calcine Retrieval and Onsite Transport	E4	AA3	AA3	AA3	AA3	AA3	AA3	AA3	AA3	AA3
MTRU waste/SBW Retrieval & Onsite Transport	E5		AA24	AA24	AA24	AA24	AA24	AA24	AA24	AA24
Separation	E6		AA6	AA4	AA4	AA5				AA6
Class C Grout	E7					AA7				AA7
Borosilicate Vitrification	E8			AA8	AA8				AA9	
HLW/MTRU waste/SBW Immobilization for Transport (e.g., Cement, HIP, Polymer)	E9						AA11	AA12		AA10
Liquid Waste Stream Evaporation	E10		AA14	AA14	AA14	AA14	AA14	AA14		
Additional Off-gas Treatment	E11			AA15	AA15	AA15	AA15	AA15	AA15	AA15
LLW Class C Type Grout Disposal	E12					AA16				
LLW, MLLW Disposal	E13									
HLW Onsite Storage for Transport	E14									AA17
Long-Term Onsite Storage of Calcine in Bin Sets	E15	AA20	AA20							
HLW/HLW fraction/MTRU waste/SBW Stabilization & Preparation for Transport	E16								AA23	AA18
Transuranic Waste Stabilization & Preparation for Transport	E17		AA21		AA21	AA21	AA21	AA21		AA21
Transuranic Waste Onsite Storage	E18									

a. Two accident evaluations (13 and 19) are no longer used.
b. In this table and throughout this document the AA# refers to the accident analysis that was performed in Appendix A of the TRD.
LLW = low-level waste; MLLW = mixed low-level waste; MTRU = mixed transuranic.

Table 5.2-38. Summary of bounding radiological events for the various waste processing alternatives.

Bounding accident analysis	Process title	Event Description	Maximally exposed individual dose (millirem)	Maximally exposed individual latent cancer fatality probability	Noninvolved worker dose (millirem)	Noninvolved worker latent cancer fatality probability	Offsite population (person-rem)	Latent cancer fatalities to offsite population
No Action Alternative								
ABN20	Long-Term Onsite Storage of Calcine in bin sets	Bin set system degradation over time results in failure of the outer containment and a portion of the internal containment in a bin set and the possibility of opening a bin set to the environment. Likelihood of this event increases after 2095 when monitoring and maintenance requirements would no longer be met.	170	8.5×10^{-5}	1.2×10^{4}	4.8×10^{-3}	1.3×10^{3}	0.65
DBE20	Long-Term Onsite Storage of Calcine in bin sets	Seismic failure of a bin set structure and equipment such that a release occurs with a direct pathway to the environment (no interdiction for 30 days).	9.7×10^{3}	4.9×10^{-3}	6.6×10^{5}	0.26	6.6×10^{4}	33
BDB20	Long-Term Onsite Storage of Calcine in bin sets	An aircraft crash into a bin set causes failure of the structure and the release of materials from a portion of the internal containment.	420	2.1×10^{-4}	2.9×10^{4}	0.012	3.5×10^{3}	1.8
Continued Current Operations Alternative								
ABN20	Long-Term Onsite Storage of Calcine in bin sets	Bin set system degradation over time results in failure of the outer containment and a portion of the internal containment in a bin set and the possibility of opening a bin set to the environment. Likelihood of this event increases after 2095 when monitoring and maintenance requirements would no longer be met.	170	8.5×10^{-5}	1.2×10^{4}	4.8×10^{-3}	1.3×10^{3}	0.65
DBE20	Long-Term Onsite Storage of Calcine in bin sets	Seismic failure of a bin set structure and equipment such that a release occurs with a direct pathway to the environment (no interdiction for 30 days).	9.7×10^{3}	4.9×10^{-3}	6.6×10^{5}	0.26	6.6×10^{4}	33
BDB20	Long Term Onsite Storage of Calcine in bin sets	An aircraft crash into a bin set causes failure of the structure and the release of materials from a portion of the internal containment.	420	2.1×10^{-4}	2.9×10^{4}	0.012	3.5×10^{3}	1.8

Table 5.2-38. Summary of bounding radiological events for the various waste processing alternatives (continued).

Bounding accident analysis	Process title	Event Description	Maximally exposed individual dose (millirem)	Maximally exposed individual latent cancer fatality probability	Noninvolved worker dose (millirem)	Noninvolved worker latent cancer fatality probability	Offsite population (person-rem)	Latent cancer fatalities to offsite population
			Full Separations Option					
ABN24	Mixed Transuranic Waste/SBW Retrieval and Onsite Transport	Operational error or equipment failure results in structural failure of one of the two mixed transuranic waste/SBW receiving tanks in a constructed receiving facility.	5.3×10^{-3}	2.7×10^{-9}	0.36	1.4×10^{-7}	0.056	2.8×10^{-5}
DBE04	Full Separation	An organic-oxidant (red-oil) explosion during solvent treatment in the transuranic separation or strontium extraction separations processes, results in release of a significant quantity of radioactive and chemically hazardous material and simultaneous failure of operational confinement.	460	2.3×10^{-4}	3.2×10^{4}	0.013	3.5×10^{3}	1.8
BDB08	Borosilicate Vitrification	An aircraft crash into the facility results in structural failure, process equipment damage, and subsequent fire.	6.8×10^{4}	0.034	4.6×10^{6}	1.8	6.0×10^{5}	300
			Planning Basis Option					
ABN24	Mixed Transuranic Waste/SBW Retrieval and Onsite Transport	Operational error or equipment failure results in structural failure of one of the two mixed transuranic waste/SBW receiving tanks in a constructed receiving facility.	5.3×10^{-3}	2.7×10^{-9}	0.36	1.4×10^{-7}	0.056	2.8×10^{-5}
DBE01	New Waste Calcining Facility Continued Operations	A calciner vessel explosion due to loss of operational control results in subsequent failure of HEPA filtration and a direct pathway to the environment.	350	1.8×10^{-4}	2.4×10^{4}	9.6×10^{-3}	5.9×10^{3}	2.9
BDB08	Borosilicate Vitrification	An aircraft crash into the facility results in structural failure, process equipment damage, and subsequent fire.	6.8×10^{4}	0.034	4.6×10^{6}	1.8	6.0×10^{5}	300

Table 5.2-38. Summary of bounding radiological events for the various waste processing alternatives (continued).

Bounding accident analysis	Process title	Event Description	Maximally exposed individual dose (millirem)	Maximally exposed individual latent cancer fatality probability	Noninvolved worker dose (millirem)	Noninvolved worker latent cancer fatality probability	Offsite population (person-rem)	Latent cancer fatalities to offsite population
		Transuranic Separations Option						
ABN16	Low-Level Waste Class C Type Grout Disposal	Failure of the above ground grout transport line to the Container Filling, Storage, and Shipping Area.	5.8	2.9×10^{-6}	390	1.6×10^{-4}	71	0.035
DBE05	Transuranic Separation	An organic-oxidant (red-oil) explosion, during solvent treatment results in release of a significant quantity of radioactive and chemically hazardous material and simultaneous failure of operational confinement.	1.3×10^{3}	6.5×10^{-4}	8.6×10^{4}	0.034	7.9×10^{3}	4.0
BDB05	Transuranic Separation	An earthquake with subsequent fire causes failure of three transuranic waste fraction surge tanks such that a release occurs with a direct pathway to the environment.	1.3×10^{3}	6.5×10^{-4}	8.6×10^{4}	0.034	7.9×10^{3}	4.0
		Hot Isostatic Pressed Waste Option						
ABN24	Mixed Transuranic Waste/SBW Retrieval and Onsite Transport	Operational error or equipment failure results in structural failure of one of the two mixed transuranic waste/SBW receiving tanks in a constructed receiving facility.	5.3×10^{-3}	2.7×10^{-9}	0.36	1.4×10^{-7}	0.056	2.8×10^{-5}
DBE01	New Waste Calcining Facility Continued Operations	A calciner vessel explosion due to loss of operational control results in subsequent failure of HEPA filtration and a direct pathway to the environment.	350	1.8×10^{-4}	2.4×10^{4}	9.6×10^{-3}	5.9×10^{3}	2.9
BDB14	Liquid Waste Stream Evaporation	An aircraft crash impacts the evaporator process building and release material in the high-activity waste surge tanks. The fire and crash are assumed to breach the building and provide a direct release path to the environment.	460	2.3×10^{-4}	3.2×10^{4}	0.013	3.5×10^{3}	1.8

Table 5.2-38. Summary of bounding radiological events for the various waste processing alternatives (continued).

Bounding accident analysis	Process title	Event Description	Maximally exposed individual dose (millirem)	Maximally exposed individual latent cancer fatality probability	Noninvolved worker dose (millirem)	Noninvolved worker latent cancer fatality probability	Offsite population (person-rem)	Latent cancer fatalities to offsite population
Direct Cement Waste Option								
ABN24	Mixed Transuranic Waste/SBW Retrieval and Onsite Transport	Operational error or equipment failure results in structural failure of one of the two mixed transuranic waste/SBW receiving tanks in a constructed receiving facility.	5.3×10^{-3}	2.7×10^{-9}	0.36	1.4×10^{-7}	0.056	2.8×10^{-5}
DBE01	New Waste Calcining Facility Continued Operations	A calciner vessel explosion due to loss of operational control results in subsequent failure of HEPA filtration and a direct pathway to the environment.	350	1.8×10^{-4}	2.4×10^{4}	9.6×10^{-3}	5.9×10^{3}	2.9
BDB12	Direct Cement Waste Immobilization	An aircraft crash into the Direct Cement Waste Facility causes failure of the static gravity mixer.	1.0×10^{3}	5.0×10^{-4}	7.1×10^{4}	0.028	1.1×10^{4}	5.6
Early Vitrification Option								
ABN24	Mixed Transuranic Waste/SBW Retrieval and Onsite Transport	Operational error or equipment failure results in structural failure of one of the two mixed transuranic waste/SBW receiving tanks in a constructed receiving facility.	5.3×10^{-3}	2.7×10^{-9}	0.36	1.4×10^{-7}	0.056	2.8×10^{-5}
DBE09	Borosilicate Vitrification	A steam explosion occurs in the melter due to intrusion of water into the melt cell, which causes catastrophic failure of the melter and release of vitrified waste material.	1.6	8.0×10^{-7}	110	4.4×10^{-5}	14	7.0×10^{-3}
BDB09	Borosilicate Vitrification	An aircraft crash into the facility results in structured failure of the operating melter, seal pot, and the glass canister, and a subsequent fire.	730	3.7×10^{-4}	5.0×10^{4}	0.02	6.6×10^{3}	3.3

Table 5.2-38. Summary of bounding radiological events for the various waste processing alternatives (continued).

Bounding accident analysis	Process title	Event Description	Maximally exposed individual dose (millirem)	Maximally exposed individual latent cancer fatality probability	Noninvolved worker dose (millirem)	Noninvolved worker latent cancer fatality probability	Offsite population (person-rem)	Latent cancer fatalities to offsite population
		Minimum INEEL Processing Alternative						
ABN17	High-Level Waste Interim Storage for Transport	A spill of material during canister filling operations with some of the spilled material would be entrained in the ventilation system and be exhausted into the environment.	0.25	1.310^{-7}	17	6.8×10^{-6}	2.6	1.3×10^{-3}
DBE21	Transuranic Waste Stabilization and Preparation for Transport to Waste Isolation Pilot Plant	Inadvertent criticality during transuranic waste shipping container loading operations as a result of vulnerability to loss of control over storage geometry.	3.0	1.5×10^{-6}	210	8.4×10^{-5}	120	0.06
BDB17	High-Level Waste Interim Storage for Transport	An aircraft crash breaches the facility housing and impacts a rail car containing four casks. A subsequent fire could result in the release of the inventory.	4.9×10^{3}	2.5×10^{-3}	3.4×10^{5}	0.14	5.3×10^{4}	26
		Cross-Cutting Accidents						
ABN03	Calcine Retrieval and Onsite Transport	Failure of a transfer line or cyclone housing due to operation error or equipment failure causing direct impact of heavy object such as construction crane.	0.014	7.0×10^{-9}	0.94	3.8×10^{-7}	150	0.073
DBE03/20	Calcine Retrieval and Onsite Transport	A flood causes failure of bin set #1 structure and equipment such that a release occurs after 2000 with a direct pathway to the environment.	3.8	1.9×10^{-6}	260	1.0×10^{-4}	4.5×10^{4}	22

annual likelihood for this bounding accident is estimated to be between one chance in a thousand and one chance in a million per year of facility operation. This event could result in a large dose to a nearby, unshielded maximally exposed worker that is estimated to be 218 rem, representing a 1 in 5 chance of a latent cancer fatality. However, this same bounding analysis estimates a dose to the maximally exposed offsite individual at the site boundary (15,900 meters down wind at the nearest public access) to be only 3 millirem from this accident, representing a 2 per million increase in cancer risk to that person. Most waste processing alternatives do not contribute enough fissile materials in an aqueous environment to allow criticalities to develop. There have been three criticalities at INTEC (October 16, 1959; January 25, 1961; and October 17, 1978). All three events were a result of high uranium concentration aqueous solutions finding its way to geometrically unsafe storage areas.

Chemical Releases – Chemicals used in waste processing can pose risks to workers and the public. Many chemicals are in use at INTEC at present and the quantity and types of the chemicals change overtime. The accident analysis team evaluated those chemicals that could pose the most hazard. Chemicals that pose the greatest hazard to workers and the public are gases at ambient temperatures and pressures. An example of this type of gas is ammonia, which is stored under pressure as a liquid but quickly flashes to a vapor as it is released. Chemicals such as nitric acid that are liquids at ambient conditions also could pose a toxic hazard to immediate workers. However, the potential for these types of chemicals to become airborne and travel to nearby or offsite facilities is low. Therefore, this analysis focuses on those chemicals that are gases at ambient conditions.

Technically, the release mechanism of pressurized gases involves a fraction that flashes to vapor as the gas depressurizes and a fraction that drops to the ground and forms a boiling pool. The pool-boiling rate is a function of several factors: pool area, substrate material (e.g., soil, concrete, etc.), and substrate temperature. Another factor that influences the release is the degree to which liquid droplets become entrained into the flash fraction. See Appendix C.4 of this EIS and the TRD for additional information on chemical releases.

Receptor Identification

Radiological Releases – For radiological releases, DOE evaluated the health impact or consequence of the bounding accidents by estimating the radiation dose to human receptors and the number of latent cancer fatalities for the offsite population. Most radiation dose was due to inhalation. For criticality events, the dose also included exposure to prompt critical radiation. Human receptors are people who might be exposed to or affected by source terms resulting from accidents associated with the waste processing alternatives. Three categories of human receptors used in this evaluation are:

- **Maximally-Exposed Individual:** A hypothetical individual located at 5,900 meters from INTEC at the nearest public access point from the facility location where the release occurs.

- **Noninvolved Worker:** Onsite employees not directly involved in the site's waste processing operations and that are located 640 meters from INTEC.

- **Offsite Population:** The collective sum of offsite persons within a 50-mile radius of the INTEC facilities and within the path of the source term plume with the wind blowing in the most populous direction.

Chemical Releases – To determine the potential health effects to workers and the public that could result from accidents involving releases of chemicals and hazardous materials, the airborne concentrations of such materials released during an accident at varying distances from the point of release were compared to Emergency Response Planning Guideline (ERPG) values. The American Industrial Hygiene Association established ERPG values, which are specific to hazardous chemical substances, to ensure that necessary emergency actions are taken in the event of a release. ERPG severity levels are as follows:

- **ERPG-3.** Exposure to airborne concentrations greater than ERPG-3 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop life-threatening health effects.

- **ERPG-2.** Exposures to airborne concentrations greater than ERPG-2 but less than ERPG-3 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop irreversible or other serious health effects or symptoms that could impact a person's ability to take protective action.

- **ERPG-1.** Exposure to airborne concentrations greater than ERPG-1 but less than ERPG-2 values for a period of greater than 1 hour results in an unacceptable likelihood that a person would experience mild transient adverse health effects or perception of a clearly defined objectionable odor.

Consequences Assessment

Radiological source terms were used as input into the computer program "Radiological Safety Analysis Computer Program (RSAC-5)" to estimate dose consequences for radioactive releases. DOE used this program to determine the radiation doses at receptor locations from the airborne release and transport of radionuclides from each accident sequence. Meteorological data used in the program were selected to be consistent with previous INEEL EIS analyses (i.e., SNF & INEL EIS) and are for 95 percent meteorological conditions (DOE 1995). The 95 percent meteorological condition represents the meteorological conditions that could produce the highest calculated exposures. This is defined as that condition that is not exceeded more than 5 percent of the time or is the worst combination of weather stability class and wind speed.

The population radiation doses from the computer output were then converted into expected latent cancer fatalities using dose-to-risk conversion factors recommended by the National Council on Radiation Protection and Measurements. To be conservative, the National Council on Radiation Protection and Measurements assumes that any amount of radiation carries some risk of inducing cancer. DOE has adopted the National Council on Radiation Protection and Measurements factor of 5×10^{-4} latent cancer fatality for each person-rem of radiation dose to the general public for doses less than 20 rem. For larger doses, when the rate of exposure would be greater than 10 rad (radiation absorbed dose) per hour, the increased likelihood of latent cancer fatality is doubled, assuming the body's diminished capability to repair radiation damage. DOE calculated the expected increase in the number of latent cancer fatalities above those expected for the population.

The consequences from accidental chemical releases were calculated using the computer program "Areal Locations of Hazardous Atmospheres (ALOHA)." Because chemical consequences are based on concentration rather than dose, the computer program calculated air concentrations at receptor locations. Meteorological assumptions used for chemical releases were the same as used for radiological releases.

For each accident evaluation, conservative assumptions were applied to obtain bounding results. For the most part, the assumptions in the Idaho HLW & FD EIS were consistent with those applied in other EIS documents prepared at INEEL, such as the SNF & INEL EIS (DOE 1995). However, there were some assumptions that differed.

DOE only performed a comprehensive evaluation of accidents that could result in an air release of radioactive or chemically hazardous materials to the environment. The reason for this simplification was that the short time between the occurrence of an air release and the time it would impact human health through respiration would not allow for mitigation measures other than execution of the site emergency plan. Accidents that resulted in a release only to groundwater were not generally evaluated since the time between their occurrence and their impact on the public was assumed to be long enough to take comprehensive mitigation measures. The one exception, DOE did identify bounding groundwater release accidents for which effective mitigation might not be feasible.

Also, DOE only focused on the human health and safety impacts associated with air release accidents. Other environmental impacts would also result from such events, such as loss of farm production, land usage, and ecological harm. However, these consequences were not evaluated directly since the discrimination between waste processing alternatives could be made without them.

DOE further decided not to evaluate impacts from some initiators (i.e., volcanoes) because they determined that these initiators would not provide new opportunities to identify bounding accidents. Based on evaluations in the TRD, volcanic activity impacting the INTEC was considered a beyond design basis event. This would place the event with initiators such as aircraft crashes and beyond design basis earthquakes. However, based on the phenomena associated with these initiators, volcanic activity initiated events are considered bounded by other initiators. This is because the lava flow from the eruption (basaltic volcanism) would likely cover the affected structures. Therefore, the amount that is released from process vessels and piping due to lava flow would be limited and would be bounded by events such as aircraft crashes, where the entire inventory would be impacted and available for release. See Appendix C.4 (Section C.4.1.2.4) for more detail on volcanism.

5.2.14.3 Methodology for Integrated Analysis of Risk to Involved Workers

Health and safety risk to involved workers (workers associated with the construction, operation, or decontamination and decommissioning of facilities that implement a waste processing alternative) is a potentially significant "cost" of implementing waste processing alternatives, a source that has been systematically characterized and reported in this EIS. Together with health and safety risk to the public, evaluation of involved worker risk provides a comprehensive basis for comparing waste processing alternatives on the basis of contribution to the implementation risk due to accidents. Unlike health and safety risk to noninvolved workers and the public that results mainly from facility accidents and accidents occurring during transportation, health and safety risk to involved workers results from three sources, industrial accidents, exposure to radioactive materials during normal operations, and facility accidents.

- Industrial accident risk to involved workers can result from industrial activities needed to complete major projects that implement an alternative.
- Occupational risk to involved workers results from routine exposure to radioactive materials during industrial activities that implement an alternative.
- Facility accident risk to involved workers results from accidents that release radioactive or chemically hazardous materials, accidents (e.g., criticality) that could result in direct exposure to radiation, or energetic accidents (e.g,. explosions) that can directly harm workers.

Risk to involved workers from facility accidents is evaluated in a manner analogous to noninvolved workers and the public. Consequences for involved workers are estimated using information on bounding accidents in three frequency categories with the highest potential consequences to noninvolved workers and the public. Due to limitations on the accuracy of consequence prediction codes at locations near the origin of a release, doses to involved workers are estimated proportionally based on doses to noninvolved workers at 640 meters. The method used is intended to provide consistency with the definition of facility worker utilized in the SNF & INEL EIS (DOE 1995).

Risk to involved workers from occupational exposures and industrial accidents is appraised in the Health and Safety section of the EIS (5.2.10). In the accident analysis methodology, information used to generate worker risk due to industrial accidents and occupational exposures is integrated with results of the facility accidents evaluation to produce a comprehensive perspective on involved worker risk. Due to the relatively large uncertainties involved in estimating involved worker risk, the accident analysis methodology includes the use of Monte Carlo simulation as means of gaining perspective on the importance of sensitivities and uncertainties in the information base.

5.2.14.4 Radiological Impacts to Noninvolved Workers and the Public of Implementing the Alternatives

This section analyzes the impacts or consequences of implementing the waste processing alternatives and their options. It describes (1) the major processes of each alternative, (2) the bounding accident scenarios applicable to the major processes, and (3) the resulting impact to INEEL workers and the general public. The systematic accident analysis process employed by DOE identified potentially bounding accidents for each alternative/option. The results for radiological releases are expressed in terms of the estimated impacts for the maximally-exposed individual, noninvolved worker, offsite population, and the latent cancer fatalities for the offsite population. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the processes with the particular alternative/option. Consequences for each of the potentially bounding accident scenarios are given in the tabular summaries associated with each alternative and each frequency category in the TRD.

In general, the process used in selecting the bounding accident scenario was to select the scenario with the highest consequence within each frequency bin. In some cases, one scenario had the highest consequence for the maximally-exposed individual and noninvolved worker but another scenario had higher consequences for the offsite population and latent cancer fatalities. In these cases, the scenario with the higher consequences for the offsite population/latent cancer fatalities was selected. Although this is the rule of thumb, there were several exceptions to this.

1. Abnormal and Design Basis Events for the "Active" Alternatives – Operational failures associated with the removal of calcine from bin set 1 and flood-induced failure of bin set 1 are bounding abnormal and design basis events respectively that affect all waste processing alternatives/options. In order to compare waste processing alternatives, these two accidents have been shown separately in Table 5.2-38 as accidents that cross cut treatment alternatives. In order to provide additional resolution in determining the highest risk alternatives, the scenario with the second highest consequence is also highlighted as a "bounding" scenario.

2. Highest Risk vs. Highest Consequence Scenario – Risk is defined as the product of frequency and consequence. In some cases, the scenario with the perceived higher risk was selected even though another scenario had higher consequences. The frequency bands considered in the analysis were fairly wide. For instance, the design basis frequency band is from 1.0×10^{-3} per year to 1.0×10^{-6} per year. From a risk standpoint, a scenario that is a 1,000 times more likely (e.g., 1.0×10^{-3} per year vs. 1.0×10^{-6}, per year), has a higher risk than another scenario that has a consequence that is 100 times greater. Therefore, the approach taken was to select the higher frequency/lower consequence scenario as the bounding scenario. These are identified on a case-by-case basis and identified in the relevant sections following.

3. Reconsideration of Conservatism in Model – In some scenarios, assumptions used in the development of source terms for the accident scenarios were determined to be highly conservative under different operating conditions. For instance, the beyond design basis accident for AA14 was assumed to be the same as for AA4. This is true for most alternatives except for the Continued Current Operations Alternative due to the differences in process requirements. These are noted on a case-by-case basis and identified in the relevant sections following.

Summary tables in the TRD describe potentially bounding accidents and their forecasted consequences. The TRD also provides additional information with respect to the process used to identify potentially bounding accidents, their source terms, and consequences.

No Action Alternative

Alternative/Process Data – Three major processes or functions apply to and form the basis of this accident analysis for the No Action Alternative. These are Calcine Retrieval and Onsite Transport (bin set 1 only) (AA03), Long-Term On-Site Storage of calcine in bin sets (AA20), and Long-Term Storage of Mixed Transuranic Waste/SBW (AA22). A detailed description of each of these three major processes or functions can be found in Appendix I of the TRD.

Accident Consequence – The systematic accident analysis process employed by DOE identified potentially bounding accidents for the No Action Alternative associated with the three functional activities. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the three processes. Summary tables in the TRD describe the potentially bounding accidents and their forecasted consequences. The TRD also provides additional information with respect to the process used to identify potentially bounding accidents, their source terms, and consequences. Table 5.2-38 provides a summary of the bounding radiological events for the No Action Alternative. This summary table (5.2-38) shows that degradation of the bin sets over time (after 2095, ABN20), seismic failure of a bin set (after 2095, DBE20), and an aircraft crash into a bin set (BDB20) result in the bounding abnormal, design basis, and beyond design basis accidents, respectively, for this alternative.

Continued Current Operations Alternative

Alternative/Process Data – Eight major processes or functions apply to and form the basis of this accident analysis for the Continued Current Operations Alternative. These are New Waste Calcining Facility Continued Operation (AA01), New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications (Off-Gas Treatment Facility Only) (AA02), Calcine Retrieval and On-Site Transport (Bin Set 1 Only) (AA03), Cesium Separation (Cesium Ion Exchange Only) (AA06), Liquid Waste Stream Evaporation (AA14), Long Term Onsite Storage of Calcine in Bin Sets (AA20), Transuranic Waste Stabilization and Preparation for Transport to Waste Isolation Pilot Plant (Transuranic or Transuranic and Strontium Feedstocks) (AA21), and Mixed Transuranic Waste/SBW Retrieval and Onsite Transport (AA24). A detailed description of each of these eight major processes of functions can be found in Appendix I of the TRD.

Accident Consequence – The systematic accident analysis process employed by DOE identified potentially bounding accidents for the Continued Current Operations Alternative associated with the eight functional activities. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the eight processes. Summary tables in the TRD. describe the potentially bounding accidents and their forecasted consequences. The TRD also provides additional information with respect to the process used to identify potentially bounding accidents, their source terms, and consequences. Table 5.2-38 provides a summary of the bounding radiological events for the Continued Current Operations Alternative. This summary table (5.2-38) shows that degradation of the bin sets over time (after 2095, ABN20), seismic failure of a bin set (after 2095, DBE20), and an aircraft crash into a bin set (BDB20) result in the bounding abnormal, design basis, and beyond design basis accidents, respectively, for this alternative.

Separations Alternative – Full Separations Option

Alternative/Process Data – Six major processes or functions apply to and form the basis of the accident analysis for the Full Separations Option. These are Calcine Retrieval and Onsite Transport (AA03), Full Separation (Cesium Ion Exchange, Transuranic Extraction, and Strontium Extraction) (AA04), Borosilicate Vitrification (Cesium, Transuranic, and Strontium Feedstocks) (AA08), Liquid Waste Stream Evaporation (AA14), Additional Off-Gas Treatment (AA15), and Mixed Transuranic Waste/SBW Retrieval and Onsite Transport (AA24). A detailed description of each of these six major processes or functions can be found in Appendix I of the TRD.

Accident Consequence – The systematic accident analysis process employed by DOE identified potentially bounding accidents for the Full Separations Option associated with the six functional activities. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the six processes. Summary tables in the TRD describe the potentially bounding accidents and their forecasted consequences. The TRD also provides additional information with respect to the process used to identify potentially bounding accidents, their source terms, and consequences. Table 5.2-38 provides a summary of the bounding radiological events for the Full Separations Option. This summary table (5.2-38) shows that a failure during mixed transuranic waste/SBW retrieval (ABN24), an operational failure during the full separations processes (DBE04), and an aircraft crash into the Borosilicate Vitrification Facility (BDB08) result in the bounding abnormal, design basis, and beyond design basis events, respectively, for this alternative.

Separations Alternative – Planning Basis Option

Alternative/Process Data – Nine major processes or functions apply to and form the basis of the accident analysis for the Planning Basis Option. These are New Waste Calcining Facility Continued Operation (AA01), New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications (Off-Gas Treatment Facility Only) (AA02), Calcine Retrieval and Onsite Transport (AA03), Full Separation (Cesium Ion Exchange, Transuranic Extraction, and Strontium Extraction) (AA04), Borosilicate Vitrification (Cesium, Transuranic, and Strontium Feedstocks) (AA08), Liquid Waste Stream Evaporation (AA14), Additional Off-Gas Treatment (AA15), Transuranic Waste Stabilization and Preparation for Transport to the Waste Isolation Pilot Plant (Transuranic or Transuranic and Strontium Feedstocks) (AA21), and Mixed Transuranic Waste/SBW Retrieval and Onsite Transport (AA24). A detailed description of each of these nine major processes or functions can be found in Appendix I of the TRD.

Accident Consequence – The systematic accident analysis process employed by DOE identified potentially bounding accidents for the Planning Basis Option associated with the nine functional activities. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the nine processes. Summary tables in the TRD describe the potentially bounding accidents and their forecasted consequences. The TRD also provides additional information with respect to the process used to identify potentially bounding accidents, their source terms, and consequences. Table 5.2-38 provides a summary of the bounding radiological events for the Planning Basis Option. This summary table (5.2-38) shows that an operational failure during mixed transuranic waste/SBW retrieval (ABN24), a failure during continued operation of the calcining facility (DBE01), and an aircraft crash into the Borosilicate Vitrification Facility (BDB08) result in the bounding abnormal, design basis, and beyond design basis accidents respectively, for this alternative.

Separations Alternative – Transuranic Separations Option

Alternative/Process Data – Eight major processes or functions apply to and form the basis of this accident analysis for the Transuranic Separations Option. These are Calcine Retrieval and Onsite Transport (AA03), Transuranic Separation (Transuranic Extraction Only) (AA05), Low-Level Waste Class C Type Grout (AA07), Liquid Waste Stream Evaporation (AA14), Additional Off-Gas Treatment (AA15), Low-Level Waste Class C Type Grout Disposal (AA16), Transuranic Waste Stabilization and Preparation for Transport to the Waste Isolation Pilot Plant (Transuranic or Transuranic and Strontium Feedstocks) (AA21), and Mixed Transuranic Waste/SBW Retrieval and Onsite Transport (AA24). A detailed description of each of these eight major processes or functions can be found in Appendix I of the TRD.

Accident Consequence – The systematic accident analysis process employed by DOE identified potentially bounding accidents for the Transuranic Separations Option associated with the eight functional activities. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the eight processes. Summary tables in the TRD describe the potentially bounding accidents and their forecasted consequences. The TRD also provides additional information with respect to the process used to identify potentially bounding accidents, their source terms, and consequences. Table 5.2-38 provides a summary of the bounding radiological events for the Transuranic Separations Option. This summary table (5.2-38) shows that an operational failure during Low-Level Waste Class C Type Grout Disposal (ABN11), an operational failure during the transuranic separations process (DBE05), and an aircraft crash into the transuranic separations facility (BDB05) result in the bounding abnormal, design basis, and beyond design basis accidents, respectively, for this alternative.

Non-Separations Alternative – Hot Isostatic Pressed Waste Option

Alternative/Process Data – Eight major processes or functions apply to and form the basis of this accident analysis for the Hot Isostatic Pressed Waste Option. These are New Waste Calcining Facility Continued Operations (AA01), New Waste Calcining Facility High-Temperature and Maximum Achievable Control Technology Modifications (Off-Gas Treatment Facility Only) (AA02), Calcine Retrieval and Onsite Transport (AA03), High-Level Waste/Mixed Transuranic Waste/SBW Immobilization for Transport (Hot Isostatic Press) (AA11), Liquid Waste Stream Evaporation (AA14), Additional Off-Gas Treatment (AA15), Transuranic Waste Stabilization and Preparation for Transport to the Waste Isolation Pilot Plant (Transuranic or Transuranic and Strontium Feed stocks) (AA21), and Mixed Transuranic Waste/SBW Retrieval and Onsite Transport (AA24). A detailed description of each of these eight major processes or functions can be found in Appendix I of the TRD.

Accident Consequence – The systematic accident analysis process employed by DOE identified potentially bounding accidents for the Hot Isostatic Pressed Waste Option associated with the eight functional activities. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the eight processes. Summary tables in the TRD describe the potentially bounding accidents and their forecasted consequences. The TRD also describes additional information with respect to the process used to identify potentially bounding accidents, their source terms, and consequences. Table 5.2-38 provides a summary of the bounding radiological events for the Hot Isostatic Pressed Waste Option. This summary table (5.2-38) shows that an operational failure during mixed transuranic waste/SBW retrieval (ABN24), a failure during continued operation of the calcining facility (DBE01), and an aircraft crash into the liquid waste evaporation process (BDB14) result in the bounding abnormal, design basis, and beyond design basis accidents, respectively, for this alternative.

Non-Separations Alternative – Direct Cement Waste Option

Alternative/Process Data – The Direct Cement Waste Option has eight major processes or functions that have applicability to this accident analysis. These eight major processes, described in the following paragraphs, are the basis for this alternative accident analysis. These are New Waste Calcining Facility Continued Operation (AA01), New Waste Calcining Facility with High-Temperature and Maximum Achievable Control Technology Modifications (Off-Gas Treatment Facility Only) (AA02), Calcine Retrieval and Onsite Transport (AA03), Direct Cement Waste Immobilization for Transport (AA12), Liquid Waste Stream Evaporation (AA14), Additional Off-Gas Treatment (AA15), Transuranic Waste Stabilization and Preparation for Transport to the Waste Isolation Pilot Plant (Transuranic or Transuranic and Strontium Feedstocks) (AA21), and Mixed Transuranic Waste/SBW Retrieval and Onsite Transport (AA24). A detailed description of each of these eight major processes or function can be found in Appendix I of the TRD.

Accident Consequence – The systematic accident analysis process employed by DOE identified potentially bounding accidents for the Direct Cement Waste Option associated with the eight functional activities. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the eight processes. Summary tables in the TRD (DOE 1998) describe the potentially bounding accidents and their forecasted consequences. The TRD also provides additional information with respect to the process used to identify potentially bounding accidents, their source term, and consequences. Table 5.2-38 provides a summary of the bounding radiological events for the Direct Cement Waste Option. This summary table (5.2-38) shows that an operational failure during mixed transuranic waste/SBW retrieval (ABN24), a failure during continued operation of the calcining facility (DBE01), and an aircraft crash into the direct cement process facility (BDB12) result in the bounding abnormal, design basis, and beyond design basis accidents, respectively, for this alternative.

Non-Separations Alternative – Early Vitrification Option

Alternative/Process Data – Five major processes or functions apply to this accident analysis for the Early Vitrification Option and form the basis for the accident analysis. These are Calcine Retrieval and Onsite Transport (AA03), Borosilicate Vitrification (Calcine and SBW Feedstocks) (AA09), Additional Off-Gas Treatment (AA15), Mixed Transuranic Waste/SBW Stabilization and Preparation for Transport to Waste Isolation Pilot Plant (AA23), and Mixed Transuranic Waste/SBW Retrieval and Onsite Transport (AA24). A detailed description of each of these five major processes or function can be found in Appendix I of the TRD.

Accident Consequence – The systematic accident analysis process employed by DOE identified potentially bounding accidents for the Early Vitrification Option associated with the five functional activities. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the five processes. Summary tables in the TRD describe the potentially bounding accidents and their forecasted consequences. The TRD also provides additional information with respect to the process used to identify potentially bounding accidents, and their source terms, and consequences. Table 5.2-38 provides a summary of the bounding radiological events for the Early Vitrification Option. This summary table (5.2-38) shows that an operational failure during mixed transuranic waste/SBW retrieval (ABN24), an operational failure during operation of the Borosilicate Vitrification Facility (DBE09), and an aircraft crash into the Borosilicate Vitrification Facility (BDB09), result in the bounding abnormal, design basis, and beyond design basis accidents, respectively, for this alternative.

Minimum INEEL Processing Alternative

Alternative/Process Data – Nine major processes or functions apply to and form the basis of this accident analysis for the Minimum INEEL Processing Alternative. There are Calcine Retrieval and On-Site Transport (AA03), Cesium Separation (Cesium Ion Exchange Only) (AA06), Low-Level Waste Class C Type Grout Process (AA07), HLW/Mixed Transuranic Waste/SBW Immobilization for Transport (Calcine and Cesium Ion Exchange Resin Feedstocks) (AA10), Additional Off-Gas Treatment (AA15), High-Level Waste Interim Storage for Transport (AA17), High-Level Waste/High-Level Waste Fraction Stabilization and Preparation for Transport (Calcine and Cesium Resin Feedstocks) (AA18), Contact-Handled Transuranic Waste Stabilization and Preparation for Transport to Waste Isolation Pilot Plant (Transuranic or Transuranic and Strontium Feedstocks) (AA21), and Mixed Transuranic Waste/SBW Retrieval and Onsite Transport (AA24). A detailed description of each of these nine major processes or functions can be found in Appendix I of the TRD.

Accident Consequence – The systematic accident analysis process employed by DOE identified potentially bounding accidents for the Minimum INEEL Processing Alternative associated with the nine functional activities. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the nine processes. Summary tables in the TRD describe the potentially bounding accidents and their forecasted consequences. The TRD also provides additional information with respect to the process used to identify potentially bounding accidents, their source terms, and consequences. Table 5.2-38 provides a summary of the bounding radiological events for the Minimum INEEL Processing Alternative. This summary table (5.2-38) shows that an operational failure during high level waste interim storage (ABN17), an inadvertent criticality during transuranic waste stabilization and packaging (DBE21), and an aircraft crash into casks awaiting transport to the Hanford Site (BDB17) result in the bounding abnormal, design basis, and beyond design basis accidents, respectively, for this alternative.

5.2.14.5 Impacts of Chemical Release Accidents on Noninvolved Workers and the Public to Implement the Alternatives

This section discusses the impacts or consequences of chemical releases from accidents that occur as a result of a implementing the waste processing alternatives and their options. It describes (1) the major processes that contribute chemicals to the atmosphere during an accident and (2) the impacts to INEEL workers and the general public in terms of Emergency Response Planning Guideline values. Potentially bounding chemical release accidents from the TRD include mercury (AA02) and ammonia (AA15). Mercury could be released from the carbon bed filter during an exothermic reaction that results from inadequate nitrous oxide reduction. Ammonia could be released during failure of the ammonia storage tanks. Current feasibility studies for several waste processing alternatives identify a need for additional offgas treatment to meet EPA environmental requirements during separation, vitrification, and other functions associated with alternative implementation. These same feasibility studies have identified an ammonia-based treatment process as being most likely to meet the technical requirements of the waste processing alternatives. Thus ammonia has been identified as a chemical substance posing a potential significant hazard to workers and the public during waste processing alternative implementation. Current design studies are identifying alternative processes for meeting environmental compliance requirements that do not require the use of ammonia. However, at this time the ammonia-based process is still considered a potential source of bounding accidents.

Alternative/Process Data – Two major processes or functions can produce chemical releases from accidents resulting during implementation of waste processing alternatives. These are New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications (AA02), and Additional Off-Gas Treatment (AA15).

Accident Consequence – Summary tables in the TRD present the chemical accidents and the impacts of these accidents. The TRD also provides additional information with respect to the process used to identify bounding accidents, their source terms, and consequences. Table 5.2-39 provides a summary of the bounding chemical events for all waste processing alternatives/options. This summary table (5.2-39) shows that failures involving ammonia handling and storage equipment (AA15) represents the bounding abnormal, design basis, and beyond design basis chemical release accidents for all alternatives requiring additional offgas treatment. BDB15 which involves an aircraft crash and subsequent fire is a threat since it results in an "external initiator" that could in turn result in a release from another waste processing facility due to operator incapacitation or evacuation.

5.2.14.6 Groundwater Impacts to the Public of Implementing the Alternatives

The bounding accident scenarios described in the preceding sections produce human health consequences mainly as a result of inhalation of air releases. In EIS accident analysis, it is generally assumed that the inhalation pathway is the predominant source of human health consequences since an air release does not provide an opportunity for intervention and mitigation.

Several potentially bounding accident scenarios from the detailed accident evaluation process produced mainly groundwater releases. In theory, groundwater releases can be mitigated, with little ultimate impact on the public. However, since significant groundwater releases would produce a substantive risk to the environment and the opportunity to mitigate may be limited by time and resource constraints, the impact of accident scenarios resulting in groundwater releases is considered in the facility accidents evaluation.

Environmental risk is usually presented in the Remedial Investigation/Feasibility Study process in terms of expected contamination at the site boundary as a function of time. Therefore, the metrics of environmental risk such as maximum contaminant levels can be used to estimate the potential for future adverse human health impacts. Specifically, expected contamination due to a postulated release can be compared with maximum contaminant levels to assess the environmental risk associated with a release.

Table 5.2-39. Summary of bounding chemical events for the various waste processing alternatives.

Events	Bounding accident analysis	Process title	Event description	Contaminant	Peak atmospheric concentration (ERPG)
Abnormal	AA15	Additional Off-Gas Treatment	Failure of ammonia tank connections results in a spill of 150 pounds per minute of liquid ammonia. A fraction of the ammonia would flash to vapor as it escapes the tank. The remainder would settle and form a boiling pool.	Ammonia	Less than ERPG-2 at 3,600 meters
Design Basis	AA15	Additional Off-Gas Treatment	Failure of ammonia tank connections results in a spill of 1,500 pounds per minute of liquid ammonia. A fraction of the ammonia would flash to vapor as it escapes the tank. The remainder would settle and form a boiling pool.	Ammonia	Greater than ERPG-2 at 3,600 meters
Beyond Design Basis	AA15	Additional Off-Gas Treatment	Failure of ammonia tank connections results in a spill of 15,000 pounds per minute of liquid ammonia. A fraction of the ammonia would flash to vapor as it escapes the tank. The remainder would settle and form a boiling pool.	Ammonia	Greater than ERPG-2 at 3,600 meters

ERPG = Emergency Response Planning Guidelines.

Following this approach, accident scenarios resulting in a release to groundwater can be appraised for their potential contribution to environmental risk and the overall economic impact of the accident.

Alternative/Process Data – Appendix C.4 presents analyses of two major processes or functions that can produce groundwater releases from accidents. These are New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications (AA02) and Long-Term Onsite Storage of Mixed Transuranic Waste/SBW (AA22).

Accident Consequence – The predicted impacts to groundwater from accident scenarios resulting in major groundwater releases are summarized in Table C.4-21 through C.4-23 in Appendix C.4. From the summary tables in Appendix C.4, it can be concluded that groundwater releases involving organic constituents such as benzene from kerosene (ABN02 and BDB02) could add substantially to the organic contamination remediation requirements for INTEC.

Accident ABN02 would release to groundwater the entire inventory of kerosene from storage facilities associated with the New Waste Calcining Facility. This is considered to be an abnormal event with an occurrence equal to or greater than once in 1,000 years. A similar but less probable occurrence (BDB02) would be an aircraft crash into both kerosene storage tanks. The estimated chance of occurrence for this event is less than one in one million.

In both cases, the kerosene is assumed to spill and form a pool about 3 inches deep. After pooling, the kerosene could seep into the available soil pore space to a depth of about 16 inches and could cover an area about 100 feet in diameter. The soil concentration could approach 100 milligrams of kerosene per kilogram of soil. If the kerosene spill were not remediated, it could move through the soil toward the aquifer in about 200 years (for the benzene component). ABN02 is estimated to cause peak groundwater concentrations of 24 times the Maximum Contaminant Level or 120 micrograms per liter. Such a release would also be the maximum reasonably foreseeable hazardous material accident for public consequences, but no fatalities would be expected. Accident BDB02 is estimated to cause a peak groundwater contamination of 180 micrograms per liter. However, since INTEC would be operational during a kerosene spill, emergency crews would take immediate action to stop the spill, halt the spread of kerosene, and dispose of contaminated soil. It is estimated that remediation could involve removal of 5 to 10 cubic yards of soil.

An intrusion scenario (ABN22) that results in a release of 10 percent of a mixed transuranic waste/SBW tank contents, would not add substantially to the site mitigation requirements. An earthquake release accident (DBE22) would also not add substantially to groundwater remediation requirements for radionuclides. Even though the release to surface soil from a seismic event would be difficult to remediate, the predicted impact to groundwater would result in a small increase in groundwater activities. Detailed explanation of modeling input parameters, source inventories, and results are contained in Appendix C.4.

Although accident DBE22 involved the seismic failure of a single Tank Farm tank containing mixed transuranic waste/SBW, one could bound the potential impact of tank failures by postulation failure of all five remaining tanks simultaneously. Using the estimated peak groundwater concentration of iodine-129 from DBE22 (0.9 picocuries per liter), DOE conservatively estimated a concentration of 4.5 picocuries per liter for failure of five tanks. Using the concentration-to-dose conversion factor from DOE (1988), and 72 years of water ingestion at 2 liters per day, DOE estimated a lifetime effective dose equivalent of 66 millirem or 33 in a million increase in probability of cancer.

In addition, either long term degradation of the bin sets, a flood, or an airplane crash (see accident analyses AA03 and AA20 in Appendix C.4) would disperse mixed HLW calcine to the environment by air dispersion. If a flood or heavy rainfall were to occur before an emergency response by the Government, the flow of water could further disperse the calcine (a scenario not analyzed in accident analyses AA03 and AA20). Although the primary short-term impact to human receptors of theses accidents would be from airborne contamination, the released calcine could deposit onto soils surrounding the bins, move with the surface water runoff to low-lying areas, and partially re-suspend in the air directly or as a result of water evaporation. Direct ground contamination would be expected within a few miles of INEEL. Calcine could subsequently slowly dissolve and release some contaminants to the groundwater; however, most of the available contaminants would be bound up in the first few feet of the soil column. Iodine-129 and plutonium could migrate to the groundwater over a very long period of time. Any groundwater impacts would be much lower than those analyzed for other accidents such as the failure of storage tank full of mixed transuranic waste/SBW (as described earlier in this subsection).

5.2.14.7 Consideration of Other Accident Initiators

Each of the process elements associated with the different waste processing alternatives and options was evaluated by the accident analysis team using a consistent set of accident initiators. During the review of the accident analysis, additional initiators were identified that could potentially result in releases of radioactive or hazardous materials. However, the bounding accidents that describe the potential risk associated with the waste processing alternatives and the accident analyses were not modified as a result of identifying these additional initiators for the following reasons:

Initiator Frequency is Less Than Beyond Design Basis – Very low likelihood events (e.g., meteor strikes) have the potential to cause significant releases. However, accidents that have a frequency of occurrence much less than 1.0×10^{-7} pose a limited risk of occurrence and do not impact the choice of bounding accidents.

Initiator is Encompassed by Another Initiator – The consequences and initiating frequencies of some newly identified initiators are bounded by accidents already identified in the accident analysis. For instance, a release could originate from an aircraft crash (included in analysis) or volcanic activity (identified in review process). The magnitude of the release and the initiating event frequencies for both initiators are similar and for all intents and purposes, the risk is the same. In this case, the volcanic activity initiator is not added into the accident analysis.

Initiator is in Planning/Hypothetical Stage – Some newly identified initiators are associated with potential future activities in and around the INEEL site. For instance, the Venture Star project is currently in the planning stage and could potentially impact the INEEL site. However, for activities such as these, their impact on waste processing alternatives would be evaluated as plans for initiation of the project are defined.

5.2.14.8 Sensitivity Analysis

The Idaho HLW & FD EIS accident analysis consequence modeling was performed for three receptors as defined above.

For each of these analyses, conservative assumptions were applied to obtain bounding results. For the most part, the assumptions in the Idaho HLW & FD EIS were consistent with those applied in other EIS documents prepared at the INEEL, such as the SNF & INEL EIS (DOE 1995). However, there were some assumptions that differed. Of the assumptions incorporated in the Idaho HLW & FD EIS consequence modeling, exposure pathways, exposure time, breathing rate, meteorology, and location (for the population dose) were some that had significant impact on the results. Table C.4-24 in Appendix C.4 summarizes the potential effects that may be observed if these assumptions are changed.

The approach that was taken in the Idaho HLW & FD EIS consequence modeling was done to ensure that a "consequence envelope" was provided. As discussed above, this approach differs in part from the approach taken in other EISs, such as the SNF & INEL EIS. Due to this, the results presented in the Idaho HLW & FD EIS are larger than the results that would have been obtained by applying the SNF & INEL EIS assumptions. However, the key issue at hand is that the Idaho HLW & FD EIS is providing a likely upper bound to the potential consequences for the accidents associated with the candidate alternatives. In addition, these conservative assumptions were incorporated in a consistent manner. Although adjustments to these assumptions will modify the absolute magnitudes of the predicted consequences, they will not modify the relative ranking of the modeled scenarios. So the set of bounding scenarios are anticipated to remain the same. More detail can be found in King (1999).

5.2.14.9 Risk to Involved Worker

Appendix C.4 provides comprehensive and integrated evaluation of involved worker risk (in fatalities per year) as a result of industrial accidents, occupational exposures, and facility accidents. Appendix C.4 develops baseline estimates of involved worker risk using point estimates of risk contributors. Appendix C.4 also provides simulated estimates of involved worker risk developed through Monte Carlo simulations. Results of the baseline estimates of involved worker risk are given in Figure 5.2-8, while results of the Monte Carlo simulations are summarized in Figure 5.2-9.

From Figures 5.2-8 and 5.2-9 several conclusions can be drawn:

- Mean values of involved worker risk from the simulations are higher than those obtained from point estimates. Involved worker risk for all alternatives are sensitive to parameters such as the number of worker years of exposure, the rate of industrial accident fatalities, and the frequency of radiological release accidents. The simulated means tend to bound the potential for involved worker risks by encompassing in the distributions of these variables, particularly upper bounds that represent relatively unlikely but possible conditions. Consistent with the state of knowledge regarding projects and activities associated with implementation of alternatives, the simulations provide a more bounding and hence more reliable basis for comparing alternatives at this time.

- Estimates of involved worker risk due to industrial accidents do not favor alternatives that require the largest amount of manpower during implementation. Thus options such as Planning Basis that encompass the largest requirements for facility construction as well as the longest facility operation campaigns, could pose risk to involved workers

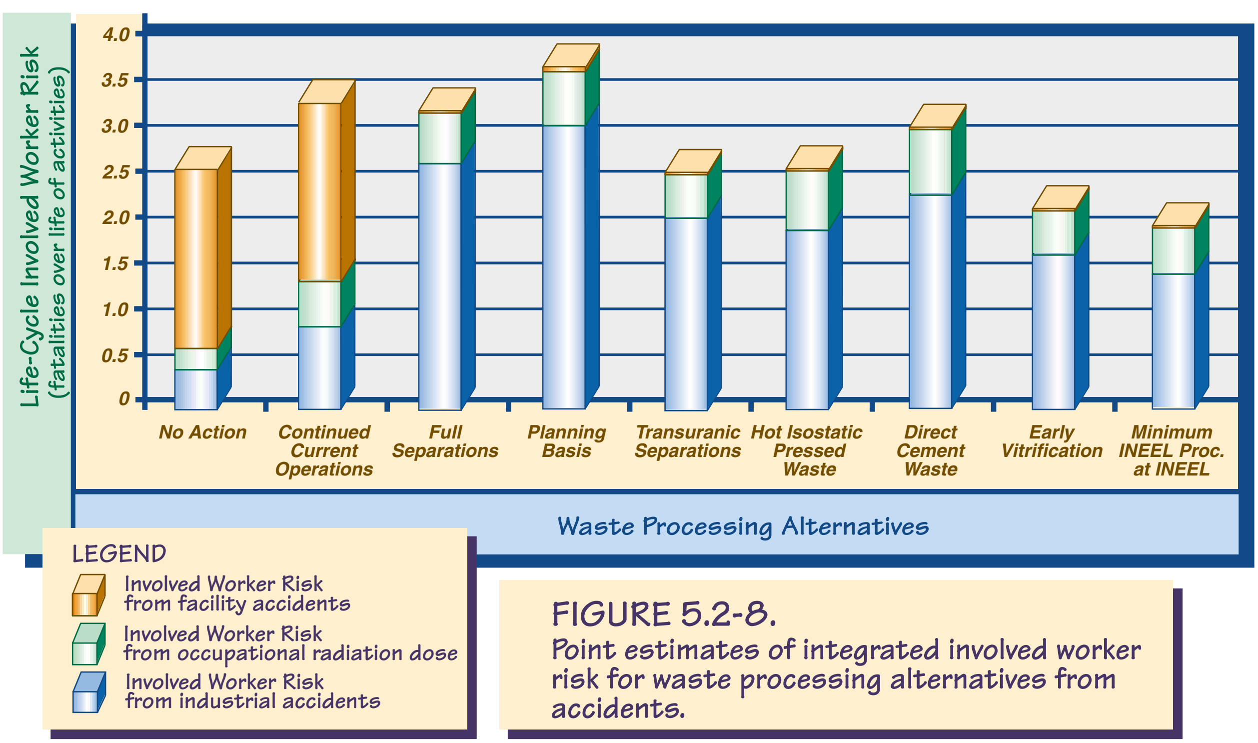

FIGURE 5.2-8.
Point estimates of integrated involved worker risk for waste processing alternatives from accidents.

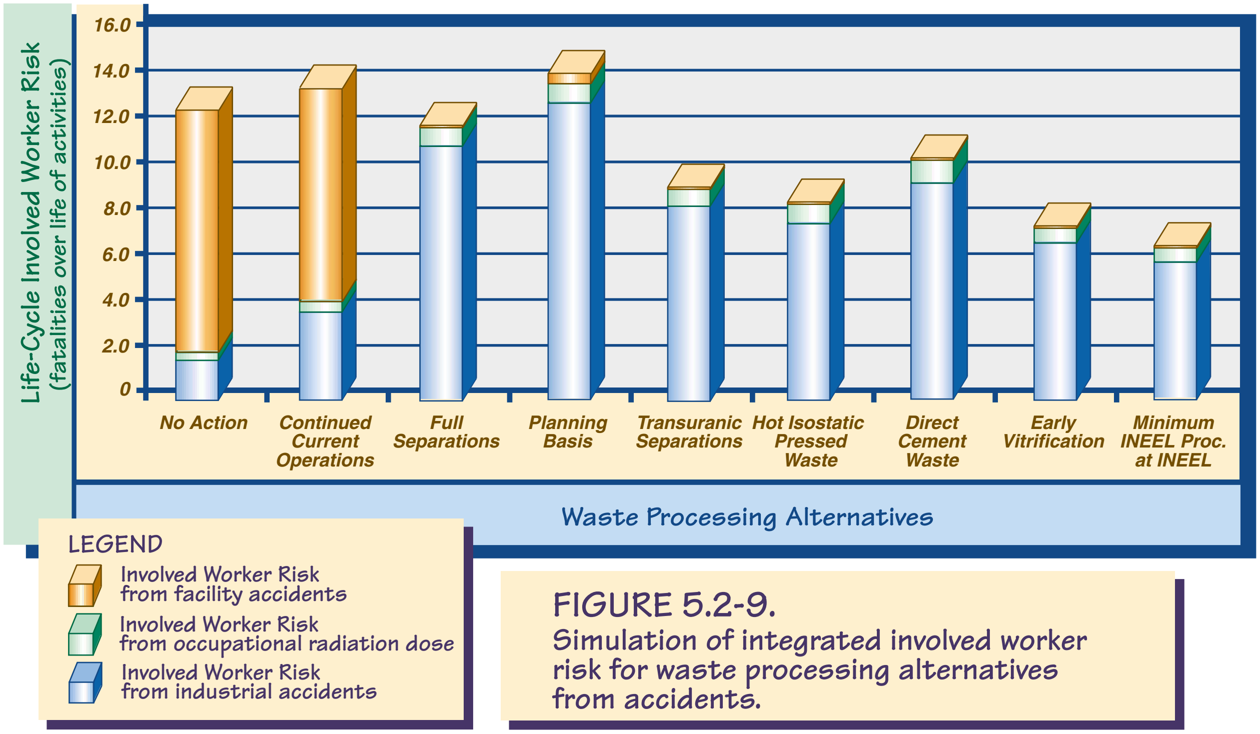

FIGURE 5.2-9.
Simulation of integrated involved worker risk for waste processing alternatives from accidents.

from industrial accidents that is a full order of magnitude higher than that posed by less ambitious alternatives.

- Estimates of involved worker risk due to facility accidents do not favor alternatives that are vulnerable to bounding accident scenarios with high probabilities of occurrence or large radioactive or chemical releases. Alternatives such as No Action and Continued Current Operations that do not address the basis issue of reducing releasable material inventories have the highest predicted combinations of likelihood and consequences for bounding accidents. As such, the contribution of facility accidents to involved worker risk for these alternatives are as much as an order of magnitude higher than the contribution for the other alternatives that actively seek to reduce risk over time.

- Industrial accidents are, for most of the alternatives, the largest contributors to involved worker risk. Therefore, estimates of integrated involved worker risk (including all sources) favor the alternatives such as No Action, Continued Operations, and Minimum INEEL Processing that involve less site activity over time. It should be remembered, however, that risks posed by transportation and activities at the Hanford site are not included in the estimates of involved worker risk for the Minimum INEEL Processing Alternative.

5.2.14.10 Comparison of Waste Processing Alternatives Based on Facility Accidents

Table 5.2-40 provides an integrated perspective on risk to noninvolved workers and the public as a result of bounding facility accidents for all the waste processing alternatives. In Table 5.2-40, accrued risk to the public from bounding accident scenarios in each frequency category are given as a fractional increase in cancer fatalities for the population at risk. Table 5.2-40 also provides comparisons of risk to the public from bounding accident scenarios with current DOE facility safety criteria. Finally, Table 5.2-40 provides an estimate of total risk to the public from facility accidents that could occur during the implementation of waste processing alternatives.

Table 5.2-40. Risks from bounding facility accidents for waste processing alternatives.

Frequency category	Bounding accident scenario	Related accident frequency [1/year]	Bounding accident frequency [1/year]	Related window of exposure [years]	Bounding window of exposure [years]	Probability of occurrence [events]	Offsite individual public dose [rem]	Offsite public LCFs [fatalities/ event]	Additional risk to offsite public [fatalites]	Fractional increase in cancer fatatlities to offsite population
	No Action									
ABN	Degradation and failure of bin set structure and equipment		1.0×10^{-3}[n]		1.0×10^{2}[h,i]	1.0×10^{-1}	1.3×10^{3}	6.5×10^{-1}	6.5×10^{-2}	3.9×10^{-6}[s]
DBE	Seismic failure of bin set structure and equipment	5.0×10^{-5}	5.0×10^{-4}[k]	1.0×10^{2}	1.0×10^{1}[h,I]	4.0×10^{-2}[r]	6.6×10^{4}	3.3×10^{1}	1.3	7.9×10^{-5}[s]
BDB	Aircraft crash failure of bin set structure and equipment		2.1×10^{-8}[g]		1.0×10^{2}[h,I]	2.1×10^{-6}	3.5×10^{3}	1.75	3.6×10^{-6}	2.1×10^{-10}
	Continued Current Operations									
ABN	Degradation and failure of bin set structure and equipment		1.0×10^{-3}[n]		1.0×10^{2}[h,I]	1.0×10^{-1}	1.3×10^{3}	6.5×10^{-1}	6.5×10^{-2}	3.9×10^{-6}[s]
DBE	Seismic failure of bin set structure and equipment	5.0×10^{-5}	5.0×10^{-4}[k]	1.0×10^{2}	1.0×10^{1}[h,I]	4.0×10^{-2}[r]	6.6×10^{4}	3.3×10^{1}	1.3	7.9×10^{-5}[s]
BDB	Aircraft crash failure of bin set structure and equipment		2.05×10^{-8}[g]		1.0×10^{2}[h,I]	2.05×10^{-6}	3.5×10^{3}	1.75	3.6×10^{-6}	2.1×10^{-10}
	Full Separations Option									
ABN	Operational failure of mixed transuranic waste/SBW retrieval and transport system		3.0×10^{-3}[m]		2.0×10^{1}[h]	6.0×10^{-2}	5.6×10^{-2}	2.8×10^{-5}	1.7×10^{-6}	1.0×10^{-10}
DBE	Organic oxidant explosion failure of Separations Facility structure and equipment		3.0×10^{-4}[j]		2.0×10^{1}[h]	6.0×10^{-3}	3.5×10^{3}	1.8	1.1×10^{-2}	6.3×10^{-7}
BDB	Aircraft crash failure of Borosilicate Facility structure and equipment		2.1×10^{-8}[g]		2.0×10^{1}[h]	4.1×10^{-7}	6.0×10^{5}	3.0×10^{2}	1.2×10^{-4}	7.3×10^{-9}
	Planning Basis Option									
ABN	Operational failure of mixed transuranic waste/SBW retrieval and transport system		3.0×10^{-3}[m]		2.0×10^{1}[h]	6.0×10^{-2}	5.6×10^{-2}	2.8×10^{-5}	1.7×10^{-6}	1.0×10^{-10}
DBE	Calciner explosion failure of New Waste Calcining Facility structure and equipment		1.0×10^{-4}[o]		2.0×10^{1}[h]	2.0×10^{-3}	5.9×10^{3}	3.0	5.9×10^{-3}	3.5×10^{-7}

Table 5.2-40. Risks from bounding facility accidents for waste processing alternatives (continued).

Frequency category	Bounding accident scenario	Related accident frequency [1/year]	Bounding accident frequency [1/year]	Related window of exposure [years]	Bounding window of exposure [years]	Probability of occurrence [events]	Offsite individual public dose [rem]	Offsite public LCFs [fatalities/ event]	Additional risk to offsite public [fatalites]	Fractional increase in cancer fatatlities to offsite population
BDB	Aircraft crash fails Vitrification Facility structure and equipment		2.1×10^{-8}[g]		2.0×10^{1}[h]	4.1×10^{-7}	6.0×10^{5}	3.0×10^{2}	1.2×10^{-4}	7.3×10^{-9}
	Transuranic Separations Option									
ABN	Operational failure of low-level waste Class C type grout transport system		3.0×10^{-3}[m]		2.0×10^{1}[h]	6.0×10^{-2}	7.1×10^{1}	3.6×10^{-2}	2.1×10^{-3}	1.3×10^{-7}
DBE	Organic oxidant explosion failure of Separations Facility structure and equipment		3.0×10^{-4}[j]		2.0×10^{1}[h]	6.0×10^{-3}	7.9×10^{3}	4.0	2.4×10^{-2}	1.4×10^{-6}[s]
BDB	Seismic failure of HLW fraction surge equipment		5.0×10^{-5}[l]		2.0×10^{1}[h]	1.0×10^{-3}	7.9×10^{3}	4.0	4.0×10^{-3}	2.4×10^{-7}
	Hot Isostatic Pressed Waste Option									
ABN	Operational failure of mixed transuranic waste/SBW retrieval and transport system		3.0×10^{-3}[m]		2.0×10^{1}[h]	6.0×10^{-2}	5.6×10^{-2}	2.8×10^{-5}	1.7×10^{-6}	1.0×10^{-10}
DBE	Calciner explosion failure of New Waste Calcining Facility structure and equipment		1.0×10^{-4}[o]		2.0×10^{1}[h]	2.0×10^{-3}	5.9×10^{3}	3.0	5.9×10^{-3}	3.5×10^{-7}
BDB	Aircraft crash fails evaporator structure and equipment		2.1×10^{-8}[g]		2.0×10^{1}[h]	4.1×10^{-7}	3.5×10^{3}	1.8	7.2×10^{-7}	4.3×10^{-11}
	Direct Cement Waste Option									
ABN	Operational failure of mixed transuranic waste/SBW retrieval and transport system		3.0×10^{-3}[m]		2.0×10^{1}[h]	6.0×10^{-2}	5.6×10^{-2}	2.8×10^{-5}	1.7×10^{-6}	1.0×10^{-10}
DBE	Calciner explosion failure of New Waste Calcining Facility structure and equipment		1.0×10^{-4}[o]		2.0×10^{1}[h]	2.0×10^{-3}	5.9×10^{3}	3.0	5.9×10^{-3}	3.5×10^{-7}
BDB	Aircraft crash fails Cement Waste Facility structure and equipment		2.1×10^{-8}[g]		2.0×10^{1}[h]	4.1×10-7	1.1×10^{4}	5.5	2.3×10^{-6}	1.3×10^{-10}

Table 5.2-40. Risks from bounding facility accidents for waste processing alternatives (continued).

Frequency category	Bounding accident scenario	Related accident frequency [1/year]	Bounding accident frequency [1/year]	Related window of exposure [years]	Bounding window of exposure [years]	Probability of occurrence [events]	Offsite individual public dose [rem]	Offsite public LCFs [fatalities/ event]	Additional risk to offsite public [fatalites]	Fractional increase in cancer fatatlities to offsite population
	Early Vitrification Option									
ABN	Operational failure of mixed transuranic waste/SBW retrieval and transport system		3.0×10^{-3}		2.0×10^{1}[h]	6.0×10^{-2}	5.6×10^{-2}	2.8×10^{-5}	1.7×10^{-6}	1.0×10^{-10}
DBE	Steam explosion fails Vitrification Facility structure and equipment		1.0×10^{-4}[p]		2.0×10^{1}[h]	2.0×10^{-3}	1.4×10^{1}	7.0×10^{-3}	1.4×10^{-5}	8.3×10^{-10}
BDB	Aircraft crash fails Vitrification Facility structure and equipment		2.1×10^{-8}[g]		2.0×10^{1}[h]	4.1×10^{-7}	6.6×10^{3}	3.3	1.4×10^{-6}	8.1×10^{-11}
	Minimum INEEL Processing									
ABN	Operations failure in canister filling facility		3.0×10^{-3}[m]		2.0×10^{1}[h]	6.0×10^{-2}	2.6	1.3×10^{-3}	7.8×10^{-5}	4.7×10^{-9}
DBE	Criticality fails transuranic waste shipping facility structure and equipment		1.0×10^{-5}[q]		2.0×10^{1}[h]	2.0×10^{-4}	1.2×10^{2}	6.0×10^{-2}	1.2×10^{-5}	7.1×10^{-10}
BDB	Aircraft crash fails railcar storage facility		2.1×10^{-8}[g]		2.0×10^{1}[h]	4.1×10^{-7}	5.3×10^{4}	2.7×10^{1}	1.1×10^{-5}	6.5×10^{-10}
	Cross-Cut, All Alternatives									
ABN	Impact failure of transfer line, bin set 1 transfer equipment		3.0×10^{-3}[a]		6.0[b]	1.8×10^{-2}	1.5×10^{2}	7.5×10^{-2}	1.4×10^{-3}	8.0×10^{-8}
DBE	Flood induced failure of bin set during calcine storage	1.0×10^{-6}	1.0×10^{-4}[c,d]	3.8×10^{2}	6.0[e,f]	4.6×10^{-3}[r]	4.5×10^{4}	2.3×10^{1}	1.0×10^{-1}	6.1×10^{-6}[s]

a. During transfer of calcine from bin set, impact of transfer lines, equipment, temporary storage would produce a release calcine waste, calcine fines, etc. directly to the environment. Scenarios resulting in dropping of a heavy load on transfer equipment or temporary storage are assumed to be dominated by human failures. Catastrophic human failure during transfer operations is assessed as 0.001/activity with 30 activities per year.

b. Transfer of calcine from a single bin set is predicated on estimates of 30 years to remove all calcine waste (7 bin sets), 2 addition years required for the first transfer.

c. Several INEEL specific evaluations of flood frequency support an estimate of 10,000 years as a recurrence frequency for a flood that reaches elevation 4912, the bottom of the berm surrounding bin set 1. Bin set 1 is known to be statically unstable. To assess the likelihood of bin set failure, it is assumed that a flood reaching the bottom of bin set 1 would liquify the earth surrounding bin set 1 and result in structural failure of the vault. Failure of the vault would result in the bin set lid falling on top of and failing the internal stainless steel bins. Calcine material would then be transported to the environment in flood waters.

d. Conditional failure of bin sets given the occurrence of a flood that reaches 4,912 feet is assumed to be 0.01 or less.

e. DOE intends to remove waste from bin set 1 at the earliest possible date. Therefore the period of vulnerability for bin set 1 flooding is assumed to be 10 years or less.

f. DOE does not intend to remove waste from bin sets 2 through 7 under no action and continued operations scenarios. Period of vulnerability for flooding failure of bin sets 2 through 7 is estimated based on 475 years of remaining useful design life minus 95 years (to 2095) after which mitigation efforts in a flood cannot be assured.

Table 5.2-40. Risks from bounding facility accidents for waste processing alternatives (continued).

g. Data from NUREG 800 and military sources agree that the frequency of aircraft impacts decreases with distance from an existing runway, from 1.7×10^{-7}/movement-sq.mi. within a mile of the runway to 1.2×10^{-9}/movement-sq.mi. at 10 miles. After 5 miles the rate of decrease is dramatically less, and it is assumed that the rate beyond 10 miles is asymptotic to 1.0×10^{-9}/movement-sq.-mi. It is assumed that aircraft with sufficient mass to penetrate a bin set land and take off from Idaho Falls airport at a rate of 6 per day or 2,190 movements/year. It is also assumed that INTEC bin sets and other facilities with potentially hazardous inventories occupy approximately 6 acres of exposed land area. Therefore the area over which aircraft induced fires and releases can occur is less than 0.01 sq.-mi.

h. Period of vulnerability for operational or external events threatening INTEC facilities is estimated based on the estimated time the facility is in use, or the time at which the contents of the facility no longer pose a significant offsite hazard.

i. Half lives of strontium-90 and cesium-137 are 27.7 and 30.2 years respectively. Risk from air releases of stored calcine is assumed to be dominated by cesium and strontium release components. Significant risk exists up to the period of time in which Cs decays to < 10% of its existing inventory, a period of 100 years.

j. An oxidant explosion is modeled as a complex set of human errors and equipment failures. Without a systems model, it is difficult to predict a systems based event frequency. Several similar failures have occurred over approximately 1,000 years of reprocessing operations around the world. If the conditional likelihood of a catastrophic explosion is 0.01 the frequency of the event is estimated to be 3×10^{-5}/year.

k. Bin sets 2 through 7, designed to meet STD 1024 criteria, should withstand a 10,000 year earthquake. The frequency of seismic induced failure for bin sets 2 through 7 is estimated using a fragility factor of 2. Division of STD 1024 criteria by 2 provides a measure of the frequency of an earthquake that threatens the integrity of bin sets 2 through 7. Therefore, the frequency of seismic failure for bin sets 2 through 7 is 5×10^{-5}/year. Bin set 1 does not meet STD 1024. An estimate of 5×10^{-4}/year is used for frequency of earthquake induced failure.

l. Same assumptions used to evaluate bin set is used to estimate frequency of seismically induced failure for HLW storage.

m. Frequency of failure is based on likelihood of human or equipment based failure being > 0.01/year and < 0.01/year. A geometric mean of 0.03/year is used.

n. Frequency estimated to be 1×10^{-6}/year for first year of performance period, varying upward to 1 in last year of performance period. Performance period estimated to be 380 years based on 2085 cessation of maintenance and surveillance. Geometric mean of failure frequency, 1×10^{-3} is used to estimate frequency of bin set failure during performance period.

o. Estimate of 1×10^{-4}/year of New Waste Calcining Facility operation for catastrophic failure of calciner cell is estimated using Safety Analysis Report for the facility.

p. Estimate based on vulnerability to catastrophic failure of operational control allowing aqueous material to enter melter cell. 1×10^{-3}/year used to estimate loss of operational control with factor of 10 reduction to catastrophic loss.

q. Estimate based on failure of double contingency criteria given two supposedly independent failures with a frequency of 1×10^{-3}. Factor of 10 increase used to address potential for common cause failure of contingency controls.

r. Where two bounding accident scenarios with the same consequences but different frequencies of occurrence and different windows of vulnerability are defined, risk from both scenarios is evaluated cumulatively.

s. The expected consequences of this event exceed DOE facility safety assurance criteria as stated in DOE 5480.23 and DOE STD 1027 are designed to ensure that credible radiological and chemical release accidents do not occur more frequently than 1×10^{-6}/year, or contribute more than a 1 in 1,000,000 increase in latent cancers over background.

This information in Table 5.2-40 supports comparison of treatment alternatives based on the risk of facility accidents.

- Alternatives that are vulnerable to bounding accident scenarios with the highest probabilities of occurrence exhibit the highest potential for risk due to facility accidents. Alternatives such as No Action and Continued Current Operations that do not address the basis issue of reducing releasable material inventories have the highest predicted combinations of likelihood and consequences for bounding accidents, thus posing risk to the public several orders of magnitude greater than alternatives that actively reduce risk over time.

- Alternatives requiring the use of separation technology could pose relatively high risk from facility accidents. Historically experience indicates that such processes could have a relatively high likelihood of accidents that result in significant and energetic release of materials. The Transuranic Separations Option, in particular, illustrates this vulnerability for the design basis event.

- Based on the results of the accident analysis, bounding accidents involving storage of calcine in bin sets indefinitely (the No Action and Continued Current Operations alternatives) would appear to exceed DOE safety assurance guidelines for facility operation. These results can be placed in perspective; however, since very conservative methods were used to forecast human health consequences in an accident.